was going to be cleared or could be cleared worked in the favor of the PCS band.

The Commission also subsequently, for the service rules and the PCS band, issued relatively flexible technical requirements. There were very few technical requirements levied upon the PCS operators. There were EIRP limits. There were 47 dB microvolts per meter field strength limits at the boundary and there was the meg 13 dBm per megahertz out of band emission limits. And that right there pretty much sums the total technical constraints on the PCS operators. Within those constraints they were allowed to deploy any technology they wanted to on the PCS block and that flexible use of the spectrum, I think, worked out quite well in the band and the industry came together and basically worked quite well on the PCS band.

So I think the way the PCS spectrum was allocated, a fair amount of spectrum with a good clearing policy and then rules that allowed for fairly flexible use within that band, I think that

was an example, interference-wise of where the Commission's process has worked well.

MR. LARSON: Okay, Andrew, if you would receive any interference other than internal interference where would that likely come from?

DR. CLEGG: Most of the interference that was not caused by our own system occurs at our geographic boundary where we have to coordinate with the co-block operator in the adjacent geographic boundary and there were industry groups like the National Spectrum Managers Association that addressed coordination procedures for coordinating frequencies at the geographic boundaries and also, frankly, like we do on our cellular operations, a lot of the frequency coordination is done fairly informally. Our engineers know the engineers from other companies and where our systems come together, if there's a problem, one of our engineers calls up one of their engineers and says hey, your choice of frequencies on this cell aren't quite compatible with ours, let's shift them around a little bit.

So it was done on a fairly informal basis as it was in the cellular band. So that's the extent of most of the interference problems we've had in the PCS band. I think it was a good model.

MR. LARSON: So would you say the coordination process there is working pretty well?

DR. CLEGG: It was. I think a combination of having an industry group to address whatever coordination procedures should be in place and also just the informal work between the companies, I think it worked pretty well in that case.

MR. LARSON: Okay, thank you. Lynn Claudy, turning to you, from the broadcaster's point of view, you've taken some spectrum hits here in both the UHF TV band. The Commission just reallocated channels 52 to 59 for new emerging uses and earlier the channel 60 to 69 bands were reallocated to public safety and other new commercial services. And you've also taken, I think, a 30 percent or so spectrum hit over in the

2 gigahertz band involving the electronic news gathering frequencies that are used by broadcasters.

In addition, the Commission is rolling out the digital television service, I think, something like 500 stations now on the air and in the process of accommodating all of the broadcasters with a second channel during the DTV transition for digital. The Commission created a concept of a de minimis interference where a DTV broadcaster is permitted to cause a certain amount of interference to analog, existing analog television.

In view of all of that, how are things going in the broadcast industry and what are your concerns?

(Laughter.)

MR. CLAUDY: Well, there's a great lurid history of broadcasting and service allocations in the Commission and since broadcasting has been around for so long since wireless services were available, I think every

technique in interference management has -- there is some example of that in broadcasting. So as a historical example, one can study broadcasting and become quite a student of spectrum management generally.

The biggest issue in broadcasting now is clearly the transition into digital services. Of course, that's midway for television and impending for radio. I think the Commission really did go a long way in the digital television service to develop new techniques, new ways of thinking about service and interference, especially in the modeling area. And that has really pushed the frontiers forward for what was an old service into the new technology era.

Now, the challenge will be that we will find out, as one always finds out with models, they have their limitations, they weren't exactly perfect. We didn't design an interference free service area. We do have areas of de minimis interference in some areas where it will be more than de minimis. So interference is going to be a

fact of life as we move to the implementation phase or further into the implementation phase.

And I think the challenge for the Commission there is how to adapt to that, to take the specific instances of interference and in some cases harmful and egregious cases and being able to work with the parties to provide the enforcement function that the Commission has with a degree of precision and timeliness and I think this is where the rubber meets the road as we go from what we figured out what the channels are and we know what the bandwidth concerns are and the interference concerns, but bringing that into the practical world and letting the parties thrive in the commercial world is going to be a big challenge for the future Commission.

MR. LARSON: Thank you. I'm not aware of a whole lot of interference problems that we've had so far with the roll out of DTV. There have been some and to my knowledge, in most of these cases anyway, the broadcasters have been working with each other to try to work out the problems.

Is that being your sense as well?

MR. CLAUDY: I think it's a dance that's just -- where the music is just starting to play. I'm not saying there's going to be a huge problem, but in the cases where that does occur and it will occur also in radio and as more -- it's not just within the broadcast band, but as new entrants come into the band, and we have more mobile transmitters and the emergency, if unlicensed devices proliferate more and trying to figure out the cumulative effects of all that kind of interference, especially with a new service in broadcasting coming in, the interlinking of all of that, I think will evidence itself in a myriad of ways. So it's not just a digital broadcaster is hurting some existing analog broadcaster or vice versa.

MR. LARSON: Okay. How are things going in your part of the world, Larry, as far as problems are going, as far as interference is concerned?

MR. MILLER: Well, my part of the world

is the same world as Glen lives in down there. We're actually a public safety frequency coordinator and when we talk about interference, I think there's a big misconception on the part of the users as to what harmful interference is as opposed to nuisance interference. And sometimes we get complaints and the guide essentially says hey, I'm hearing a guy of my channel and once I read the rules to him, how the applicants and licensees are required to cooperate and make adjustments, etcetera, and 90 percent of the time, once they realize that, they are about to work with the other parties, reducing antenna heights, transmitter power. Sometimes, you even have to take somewhat extreme measures of using directional antennas. Obviously, tune the squelch on the receivers and things like that. And for the most part that solves a vast majority of the problems.

Now when you reach a situation where that you can't quite educate the people as to the fact that they do have to share and cooperate, that's probably where we would like a little bit of

a stronger hand from the Commission. We would like to be able to just refer that to the Commission and say we've done all we can and then if the Commission were to issue a letter to the complainant stating this is what you really need to do, I think that would probably make a happy ending to most of these complaints.

MR. LARSON: So far things, I think, sound like they're going pretty well. Certainly, there must be some major problems here that we have yet to uncover.

Any of the other panelists want to jump in at this point and discuss that, that issue?

DR. STEFFES: I think a lot of us are afraid of the future as much as we are of the present.

MR. LARSON: Uh-huh.

DR. STEFFES: Just because we know the rate of growth is so significant that the minimal pressures now will become major pressures within the next four years.

I represent, of course, and again I'll

mention my comments are my own personal comments and not those of the National Academy of Sciences of the Committee on Radio Frequencies. But I will say that we have seen just an explosion in usage of spectrum around the passive services. And again, I'll remind you what passive services are, the things like radioastronomy and sensing of the earth's atmosphere and surface with passive and will receive only type equipment are typical sensitivity levels are about a trillion times higher -- well, let's see that would be 10^{12}, call it 90 dB, a billion times more sensitive than a typical radio receiver. So we're even far more sensitive than the space communication receiver. So we are in a situation where we are constantly paying attention to the growth of the spectrum usage and even a minimal out of band emission from something like a GLONASS navigation satellite can completely shut us down.

Whenever an earth-remote sensing satellite operating in the earth-remote sensing band at 10.68 gigahertz flies over Cleveland, it

basically doesn't even try because you know, there will be out of band emission from the adjacent fixed service and it's very weak and they're doing -- they're operating within their license, but basically these folks, you know, were that sensitive.

So we've seen incidents, obviously, when Iridium is very busy, we see their out of band emission, even though that was an incredible activity as far as trying to coordinate the licensing and out of band emission requirements for Iridium relative to the neighboring L band passive radioastronomy use. So I think we've seen a small problem. As a matter of fact, right now, our wonderful International Space Station, the Russian segment has a transmitter on it that is not quite allocated. And we see that at 1429 megahertz. Don't ask me how it got there. But my comment is that those of us that are most sensitive are most afraid of the future. And we're very concerned with out of band emissions.

MR. LARSON: So as hard as the

Commission is trying to protect the integrity of your operations over there with the very sensitive communications that you receive, perhaps radioastronomy is kind of a barometer here, maybe of things to come.

DR. STEFFES: Yes. And to draw a parallel with the land management concept that the two of you have brought up and Dale brought up initially, I think that if you will, we're kind of like the National Parks of the spectrum world. We're the ones that are most sensitive to pollution. We're most sensitive to environmental change, that sort of thing because of the sensitivity.

MR. LARSON: We'll soon go to the audience for questions and comments, but I want to just tap one other kind of a subissue here with Rob Briskman. Rob brings, I think, a little bit of a different perspective here to the discussion. Rob represents a newly emerging service, satellite digital radio, fresh from an FCC proceeding and I think it's still an

on-going proceeding here involving certain issues.

Rob, in your view, how transparent are the Commission's processes here for interference particularly in connection with trying to put in a new service. Are there room for improvements here, or do you think things are okay as they are?

MR. BRISKMAN: Well, I'm going to answer that in a very long answer, since my right hand here neighbor claimed the rights to maximum sensitivity.

(Laughter.)

Let me give a little bit of history since I am representing, Keith, the satellite industry here. The first commercial satellite which I launched was Early Bird in 1967. That's only 35 years ago and it was operated, as you know, at 4 in 6 for fixed service. In this 35 years, of course, and now many hundreds of satellites are used for all different sorts of things, communications, direct TV to your homes, a GPS for navigation and position determination. You mentioned Iridium and you on and on and on.

So I suppose, Keith, as a general answer, I think the Commission should be congratulated on coming up with the processes and rules that have allowed the satellite industry to grow this rapidly in 35 years and I'd like to single out the IB which was called something else back then, but is now the IB for doing most of this work.

Now the second arm of this, of course, is sensitivity. Without debating the radioastromers who do require a very high sensitivity, so do satellites. And why? I suppose for two engineering reasons. One, the economic cost which Dale will get back to of putting satellite power, transmitter power, is extremely high. And therefore, any system design tries to minimize that. This creates, obviously, receivers are very, very sensitive and this creates a very high possibility of getting interference.

Getting back to Keith's comment, of course, the current and newest service is what's called SDARs at the Commission which is a digital

audio radio service to cars. Again, it's extremely sensitive because it uses receivers that are, if you like, noise figure, I believe are a little bit one below 1 dB noise figure. If you like kelvin, it's about 160 degrees kelvin and they use omni directional antennas. So it does make it extremely sensitive to interference.

So what I'm still saying is that the efforts and procedures that the Commission, including this one, have been effective. There are concerns, and by the way, this is not only SDARS concerns, other satellites, having to do with out-of-band emissions and this has been mentioned by at least two or three of the other panelists. Without belaboring the point, I did last night go through the rules and one finds that in our band, others can put anywhere from a range of 40 dB difference in out-of-band emissions. In other words, there's a rule for wireless. There's rules for ultra-wide bands. There are rules for other Part 15/18 devices and the out-of-band emissions limits are all different and although this second, I don't

think there is a major problem. It is one that the Commission must address and address soon before there is one. Thank you.

MR. LARSON: Thank you, Rob. Well, we're finally I turn to you here and then we'll go to the audience. Welcome and I'm happy to tell you today that I'm not here to try to take away some federal spectrum here from the Government. That's not the purpose of this panel and also, I'd like you to go back and report to your superiors back there in the federal Government side, how well under control things are on the FCC side of things or seem to be.

(Laughter.)

And what civil proceedings we have here.

(Laughter.)

How are things over there on the federal government side. Are you grappling with the interference issues, just like we are here?

MS. COWEN-HIRSCH: Absolutely, and let me tell you that the Department of Defense has

addressed interference from the get go because we use such a wide plethora of systems and a very finite amount of spectrum, interference criteria is a way of life for us. And what we do very significantly different than Commission rulings is that we don't place the entire burden on the transmitter side. It is essential for our receivers to be able to have -- find discrimination and to ensure that their interference tolerance enable their mission to be complete.

Now we also have receivers that are wide open and highly sensitive, satellites as well as sensors in the most generic sense and what we do to overcome the interference because it's not a question of whether you will have interference, but when and to what degree. And what you do with technology to be able to get through that interference to accomplish the mission and get your information transmitted from point A to point B. So in the case where we have our wide open transmitters, we often use signal processing techniques and certainly technology is opening some

wide areas of exploration in that area, to be able to discriminate the information, to be able to address the noise issues.

So when we have a platform, whether it's a ship or an aircraft or a satellite that's in a highly dense environment and there's nothing more dense than an electromagnetic environment than a battlefield, the ability to address interference issues and to overcome them and to minimize them, two very, very different disciplines is critically important to the Department of Defense.

We used to, in our material solution, demand receiver standards. We have changed our acquisition processes such that receiver standards are not the mandate, but they are, in fact, a way of life in terms of ensuring that technology addresses the interference environment in a battlefield situation.

Now, all of our missions are not accomplished on the battlefield. Our missions are also accomplished here within the United States and so we're very sensitive to the potential for

interference from commercial applications, whatever they may be. We use the same technical solutions to begin to address what the regulatory arena may not, for lack of a better word, enforce. So the interference criteria and the way we address it technically, as well as taking advantage of when and where time and geography of how we use our systems mitigates the interference situation when we're operating with similar systems and certainly with dissimilar systems.

MR. LARSON: My co-moderator has a follow-up question.

MR. HATFIELD: Rebecca, this is new information to me from back when I was at NTIA on receiver standards. I just wanted you to clarify. You say it's no longer -- receiver standards are no longer mandated, but are a way of life. How does that translate into the real world?

MS. COWEN-HIRSCH: You mean the real world outside the Defense Department?

MR. HATFIELD: No, no, I mean --

(Laughter.)

MR. HATFIELD: No, I mean because I've been recently more an advocate of looking at the receiverside and I've sometimes used the Department of Defense as an example that you tended in the past to look harder and now you're saying it's not a mandate, but it's a way of life. What does that mean in practical terms if I'm designing a DOD system?

MS. COWEN-HIRSCH: Absolutely, very good question. In prior years of acquisition and when we were doing our purchasing and building of systems, there were military standards or mil standards that were levied against the provider or against the company that would be building the system for us. Because we are allowing new technology solutions, we do not levy specific standards and it's just a streamlining of acquisition and that was the previous Administration, at least in part, was their direction. This actually has been significantly advantageous for us because rather than telling someone how to do their job, we base all of our

requirements on operational requirements, so rather than forcing or directing a specific standard against which a system must be designed, we actually have an operational requirement whether it's threshold or different requirement for the data throughput such that you leave it up to the individual company and the technological solution to establish how those requirements could be met. So instead of levying a standard that the receiver meet a specific criteria, you've got a throughput requirement that indicates your quality of service, if you will, that will translate into the commercial industry. You would define what those quality of service requirements would subsequently be and allow the technology to drive the solution. It introduces greater flexibility. It also allows us to leverage where industry may be in some cases exploring new opportunities that wouldn't necessarily be consistent with an old antiquated mil standard, but would provide the necessary operational capabilities. So it basically is a quality of service requirement.

MR. HATFIELD: Could I follow up? Taking Paul's admonition to be provocative, what prevents a system from being designed that meets the requirement, but squanders spectrum? I mean I thought that's the reason you looked at receivers is to make sure that the receiver wasn't squandered and I always use you as a poster child and now you're telling me that maybe -- and Andrew, the same thing. I am probably a very strong advocate of flexibility, but the trouble is the flexibility, you can design a system what I call fragile systems, systems that are too darn sensitive to interference in which you play, and then you say everybody around you. Now you've got to cut down your out-of-band emissions because I've put a system that's what I would say is under designed. Where do you do the design review to make sure that the person is not meeting the requirement, but is squandering spectrum?

MS. COWEN-HIRSCH: From the very get-to. Not only is it the quality of service for a particular system, but it's that that system must

operate in the intended environment, so there are environmental considerations so that you can address either existing out-of-band emissions, but also take into consideration whether it's the noise environment, if you're operating in the presence of ultra-wide band or whatever the new system, you have to take the environment into consideration. And looking at -- it is absolutely essential that spectral efficiency be one consideration. Now the military has some unique situations. There are missions that we accomplish such as -- or requirements that we have like anti-jam, that is very significantly different than the broad open industry requirements. So it is not only -- we cannot tolerate because the plethora and the wide variety of systems and the finite amount of spectrum into which we are restricted because we have not addressed the breadth of sharing potentials in the broadest concept across the spectrum in total. We are restricted in the finite amount of spectrum that we do employ that we need to begin to -- we need to be fine stewards of that

spectrum and we are to allow the mission to be able to be accomplished.

MR. LARSON: Okay, thank you. Receiver standards are going to be a really important thing down the line. I think it's something we're going to be talking about more even in this panel here as we get into other segments of the panel, but the audience, you've been extremely patient here, listening to the panelists get their discussions. Now it's your turn.

Anybody have any problems that they can put their fingers on or things from your point of view, members of the audience. Are things working pretty well or are there areas that the Commission should be concerned about, about its present processes? And then after that, we'll move to our next segment on dealing with future challenges, but again, let's keep it focused on the present right now.

Questions?

(Pause.)

Yes. Please identify yourself by name

and affiliation, if you could, please?

MR. DELMORE: I'm John Delmore. And I have just a quick question for Glen Nash.

Mr. Nash, you mentioned with regards to interference. The FCC's require licensees to cooperate with each other. And I think that's what you said. Correct me if I'm wrong. If you did say that, could elaborate on how that's currently working out with public safety licensees, cooperation between public safety licensees and other licensees that may be causing interference to them, the degree of cooperation that exists and that sort of thing?

MR. NASH: Sure. Again, within the public safety community, I think there's a fairly good amount of cooperation between the licensees. And quite frankly, as I said, that begins at the frequency coordination process to minimize the potential for interference, but once it occurs, the two parties getting together and finding an amicable solution and as Larry indicated, that making adjustments in power output, making